Carbohydrate remobilization as a mechanism to reestablish leaf mass following crown scorch in 7-year-old longleaf pine

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Introduction

Frequent prescribed burns (2-4 years) are an important tool in the management and restoration of longleaf pine (*Pinus palustris* Mill.) ecosystems and often results in significant crown scorch (**Fig. 1**).

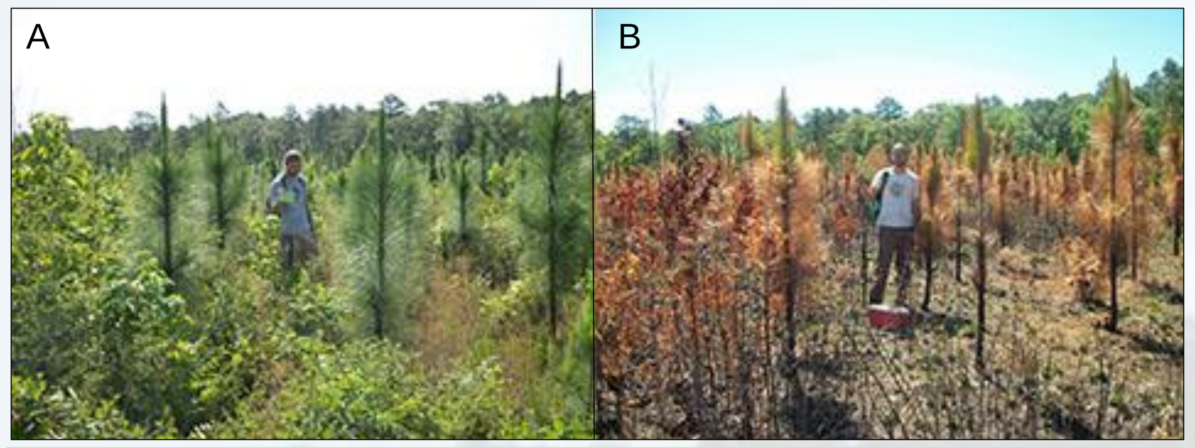


Fig 1. *Photo taken at plot center 5 days prior (Panel A; 5/11/11) and 9 days following (Panel B; 5/25/11) the spring burn (May 16th, 2011), showing the extent of crown scorch.*

We conducted spring (May 2011) and fall (Oct. 2012) prescribed burns to investigate the impacts of crown scorch on young field grown longleaf pine trees and mechanisms for crown scorch recovery. We observed no differences in stem volume up to three growing seasons following burning in either spring or fall of the year (**Fig. 2**), and the complete reestablishing total leaf

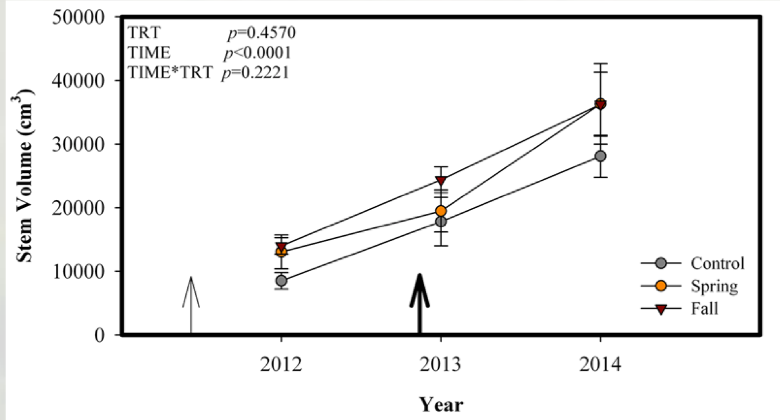


Fig 2. *Index of stem volume (D²H) by year in 7-year-old longleaf pine subjected to spring, fall, or no crown scorching (n=3). Thin and bold arrows represent the spring and fall burn, respectively.*

mass within one growing season following the prescribed burn, regardless of the season of burn (**Fig. 3**). We hypothesized that a remobilization of non-structural carbohydrates (NSC) was one possible mechanism, which allowed for the observed rapid recovery of leaf mass protecting the trees from short-term reductions in productivity.

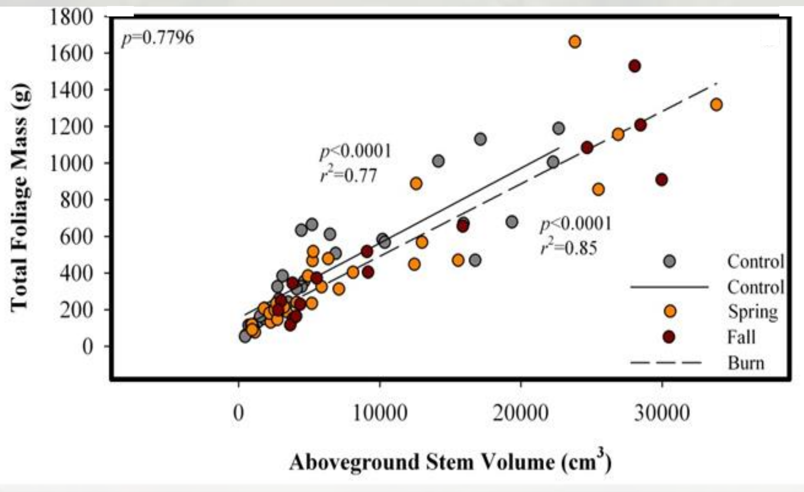


Fig 3. *Relationship between total foliar mass and index of aboveground stem volume for spring, fall, and control treatments. P-value is associated with same slopes analysis among control and burn treatments*

Objectives

1.) Determine if NSC reserves are more critical in spring relative to fall burn for the reestablishment of leaf mass as a result of seasonal pattern of the carbohydrate reserves.

2.) Test if terminal stem NSC was quickest to respond to defoliation due to their proximity and importance for leaf reestablishment.

Methods

The study site was a 7-year-old longleaf pine plantation located on the Kisatchie National Forest in central Louisiana in the Winn Ranger District (Latitude: 32° 3, 10.345"N, Longitude: 92° 51' 20.279" W). The site was planted at a 1.83 by 2.74 meter spacing with 327 trees ha-1 in Dec 2004. The study was a randomized complete block design (RCBD) replicated three times (**Fig. 4**).

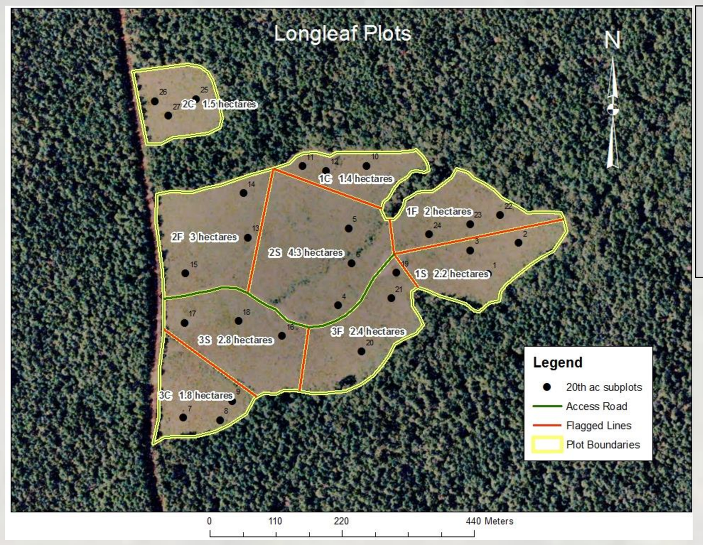


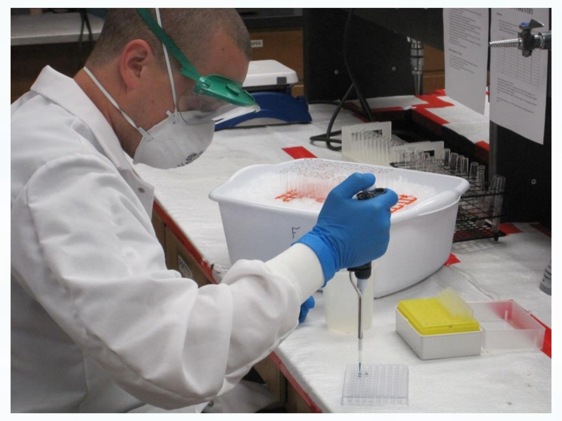
Fig 4. *Map of study site showing spring burn (S), fall burn (F), and no-burn (C) plots. Black dots represent randomly located subplots used for stem volume estimates.*

Each plot was subjected to one of three (Spring burn, Fall burn, or no burn) burning treatments. In September 2010 (six years after planting) firebreaks were installed between treatments and around the study area to prevent the spread of fire to undesired areas. The spring plots were burned on May 16, 2011 and the three fall plots were burned on October 23, 2012. The unburned (control) plots consisted of 4.7 hectares, and were used for comparisons since season was not replicated.

Sampling

Longleaf pine tissue samples were collected monthly over a 24-month period from November 2011 through October 2013. Terminal bud, stem, and taproot samples were collected from three trees that represented different size classes on each plot. Samples were freeze-dried for 72 hours and finely ground using a SPEX SamplePrep ball mill grinder (8000M Mixer/Mill; Metuchen, NJ) prior to analysis.

Methods Cont.



Soluble sugar concentrations were measured on samples collected during the five months surrounding the spring burn treatment (April, May, June, July, September; 2011) and during the four months surrounding the fall burn treatment (September, October, November, December; 2012). Soluble sugar concentrations were analyzed using an anthrone-thiourea colorimetric assay as described by Kaelke et al. (2001). The remaining sample was dried and the pellet used for starch analysis. Starch content was measured through enzymatic hydrolysis similar to the method of Haissig and Dickson (1979), and by anthrone-thiourea colorimetric assay similar to Kaelke et al (2001). Estimates of starch and soluble carbohydrates were summed to calculate total non-structural carbohydrates (NSC).

Results

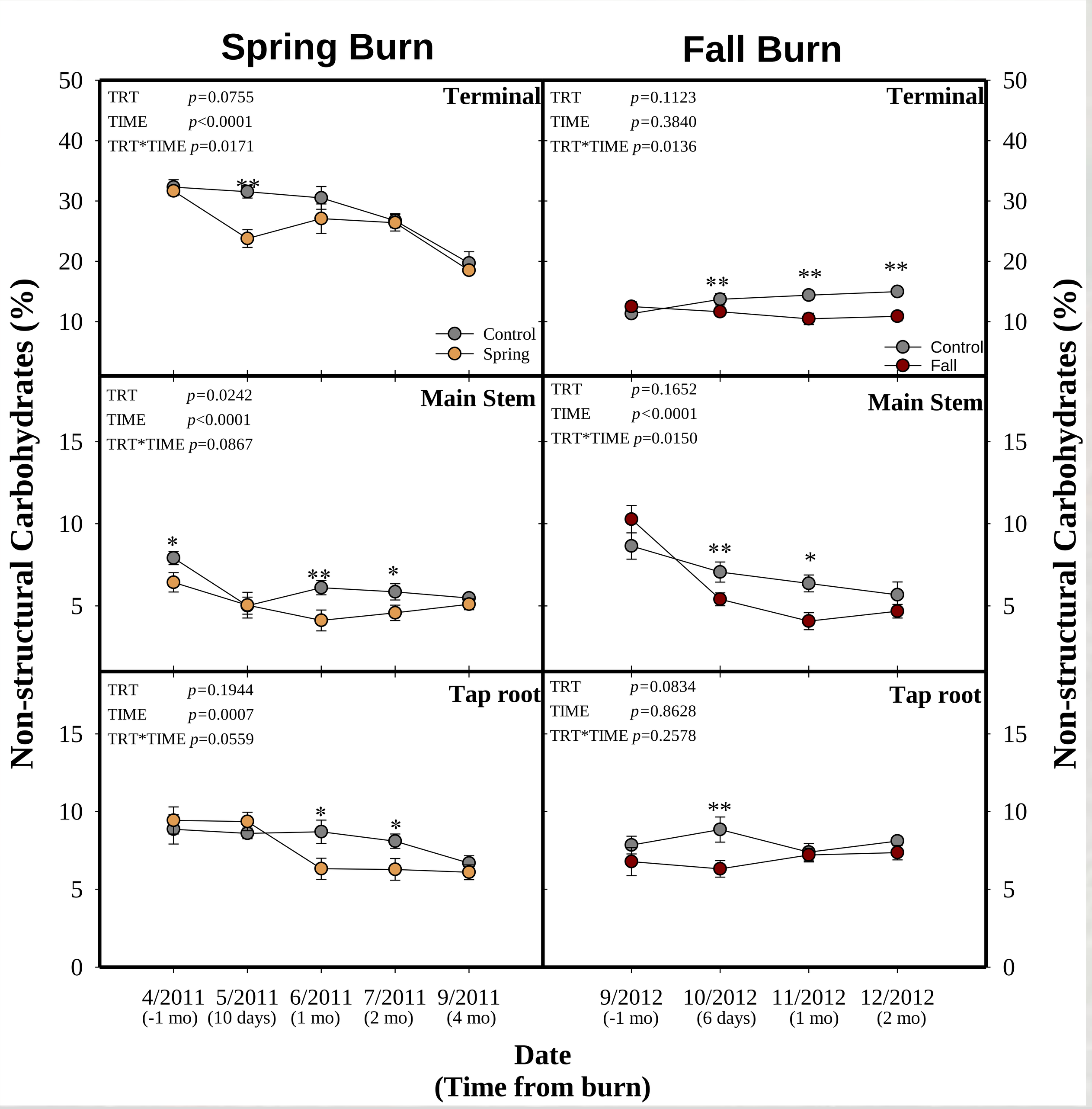


Fig 5. *Total non-structural carbohydrate for three tissue types for the spring and fall prescribed burn. Single and double asterisks indicate significance at the 0.05 and 0.01 alpha level, respectively. P-values in the upper corner of each figure frame were generated by ANOVA with repeated measures.*

Conclusions

1.) Our results showed significant reductions in NSC in all tissue types (terminal stems, main stem, tap root) following both spring and fall burns which suggests leaf mass reestablishment is partially supported by the remobilization of stored carbohydrates.

2.) All tissue types returned to control levels within four months of the spring burn, whereas terminal stem carbohydrate concentrations were still significantly lower through the end of the study.

3.) Finally, the terminal stem was an important reservoir and appeared to respond more quickly following burning relative to other tissue types.

Implications

These findings support the importance of carbohydrate reserves for the reestablishment of leaf area. Although we can not directly test differences among season of burn with this experiment there is evidence that the carbohydrate status of the plant could impact its recovery. Our findings show that the terminal buds (6 inches of the end of the branch) were most responsible for early plant responses and worth more intensive investigation in the future. This work continues as we analyze tissue collected on the remaining sampling dates and extend our data beyond four months.

References

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